

Claims:

This listing of claims replaces all prior versions and listings of the claims in the application.

Listing of Claims:

Claims 1-60 (cancelled).

61. (previously presented) In combination:

a spindle (14) having a component (26) secured thereto by a formed end (20) that is formed by deformation of a deformable annular end portion (71) on the spindle;

the component having a cylindrical opening (27) therethrough and an outer face (32);

the spindle (14) having a spindle rotational axis (X FIG. 1), a spindle outer surface (15) and a deformable annular end portion (71) with an outer end (78);

the spindle (14) having an inner beveled surface (68) that is inclined inwardly toward the spindle rotational axis (X FIG. 1) from the deformable annular end portion (71);

the deformable annular end portion (71) having a cylindrical outer surface (71a) and a tapered inner surface (72, 74) that tapers outwardly away from the spindle rotational axis (X) toward the outer end (78) so that the deformable annular end portion (71) decreases in radial thickness (between outer surface 71a and inner surface 72, 74) along its length in a direction toward its outer end (78);

the deformable annular end portion (71) being received through the opening (27) in the component (26) and being deformed generally radially outwardly and axially into a formed end (20) that holds the component (26) on the spindle (14), the deformation being such that the cylindrical outer surface (71a) of the deformable annular end portion (71) becomes an inner face

(58) of the formed end (20) that extends outwardly of the spindle rotational axis (X) in engagement with the outer face (32) of the component (26), the deformation further being such that the formed end (20) has a peripheral outside corner (64) located closely adjacent the outer face (32) of the component (26);

the deformable annular end portion (71) being deformed and worked so that both the outer end (78) and at least a portion of the tapered inner surface (72, 74) of the deformable annular end portion (71) are formed into a single curved outside surface (60) on the formed end (20) that faces outwardly generally axially of the spindle axis and curves smoothly along its length toward the spindle rotational axis (X) from the peripheral outside corner (64) of the formed end (20) that is located closely adjacent the outer face (32) of the component (26);

the curved outside surface (60) on the formed end (20) being continuously curved from the peripheral outside corner (64) of the formed end (20) adjacent the outer face (32) of the component (26) so that a point traveling along the curved outside surface (60) moves both axially outwardly and radially inwardly of the spindle axis and the thickness of the formed end (20) in a direction axially of the spindle rotational axis gradually increases along its length generally radially of the spindle axis in a direction from the peripheral outside corner (64) of the formed end (20) toward the spindle rotational axis (X).

62. (previously presented) The combination of claim 61 wherein the inner face (58) of the formed end (20) merges with the spindle outer surface (15) along an inside corner (56) and the outside surface (60, 62, 66) of the formed end (20) merges with the spindle inner beveled surface (68) at an outside intersection (C), and the diagonal thickness of the formed end (between 56 and C) in a direction generally diagonally across the inside corner (56) and the outside

intersection (C) is not less than the radial thickness (between 72, 74 and 71a) of the spindle deformable annular end portion (71) at any location along its length (from C to 78).

63. (previously presented) The combination of claim 62 wherein the intersection (C) between the spindle inner beveled surface (68) and the outside surface (60, 62, 66) of the formed end (20) is located generally diagonally opposite from the inside corner (56).

64. (previously presented) The combination of claim 61 wherein the deformable annular end portion (71) is outwardly deformed along its length from adjacent the intersection (C) of the spindle inner beveled surface (68) with the tapered inner surface (72) of the deformable annular end portion (71) to the outer end (78) of the deformable annular end portion (71).

65. (previously presented) The combination of claim 61 wherein the curved outside surface (60) of the formed end (20) merges into a generally flat outside surface (62) that extends toward the spindle rotational axis (X) from the curved outside surface (60).

66. (previously presented) The combination of claim 61 wherein the diagonal thickness of the formed end in a direction generally diagonally across the inside corner and the outside intersection (between 56 and C) is not less than the axial thickness of the formed end (20) at a location that is in alignment with the interface (15, 27) between the component cylindrical opening (27) and the spindle outer surface (15).

67. (previously presented) The combination of claim 61 wherein the formed end (20) tapers to a relatively sharp rounded edge at said peripheral outside corner thereof (64).

68. (previously presented) The combination of claim 61 wherein the tapered inner surface (72, 74) of the deformable annular end portion (71) intersects the inner beveled surface (68), the outward deformation of the deformable annular end portion (71) to produce the formed end (20) being such that the tapered inner surface (72, 74) of the deformable annular end portion (71) is outwardly deformed along its length from adjacent its intersection (C) with the inner beveled surface (68) to its outer end (78).

69. (previously presented) The combination of claim 68 wherein the intersection (C) between said tapered inner surface (72) and said inner beveled surface (68) of the deformable annular end portion (71) is generally diagonally opposite from said inside corner (56) after deformation of the deformable annular end portion (71) into the formed end (20).

70. (previously presented) In an assembly wherein a component (26) is secured on a spindle (14) by a formed end (20) that is formed by deformation of a deformable spindle annular end portion (71);

the spindle (14) having a spindle rotational axis (X FIG. 1), a spindle outer surface (15) and a deformable annular end portion (71) with an outer end (78);

the spindle (14) having an inner beveled surface (68) that is inclined inwardly toward the spindle rotational axis (X) from the deformable annular end portion (71);

the deformable annular end portion (71) having a cylindrical outer surface (71a) and a tapered inner surface (72, 74) that tapers outwardly away from the spindle rotational axis (X) toward the outer end (78) so that the deformable annular end portion (71) decreases in radial thickness (between 71a and 72, 74) along its length in a direction toward its outer end;

the component (26) having an opening (27) in which the spindle (14) is received for rotation of the component with the spindle;

the spindle deformable annular end portion (71) being deformed generally radially outwardly and axially into a formed end (20) that engages an outer face (32) of the component (26) to secure the component (26) on the spindle (14);

the formed end (20) extending outwardly of the spindle axis and terminating in a peripheral outside corner (64) located closely adjacent the outer face (32) of the component (26);

the deformable annular end portion (71) of the spindle (14) being deformed and worked so that both the outer end (78) and at least a portion of the tapered inner surface (72, 74) of the deformable annular end portion (71) are formed into a single continuously curved outside surface (60) on the formed end (20) that curves smoothly along its length toward the spindle rotational axis (X) from the peripheral outside corner (64) of the formed end (20) that is located closely adjacent the outer face (32) of the component (26);

the formed end (20) having an inside face (58) that engages the end face (32) of the component (26) and merges into the outer cylindrical spindle surface (15) along an inside corner (56);

the formed end (20) having a generally axially facing outside surface (60, 62, 66) that merges with the spindle inner beveled surface (68) at an outside intersection (C); and

the intersection (C) between the outside surface (60, 62, 66) and the spindle inner beveled surface (68) being located generally diagonally opposite from the inside corner (56).

71. (previously presented) The combination of claim 70 wherein the diagonal thickness of the formed end in a direction generally diagonally across the inside corner (56) and the intersection of the spindle inner beveled surface (68) with the outside intersection (C) is not less than the radial thickness (between 71a and 72, 74) of the spindle deformable annular end portion (20) at any location along its length (from C to 78).

72. (previously presented) The combination of claim 70 wherein the tapered inner surface (72, 74) of deformable annular end portion (71) is outwardly deformed along its length from adjacent the intersection (C) of the spindle inner beveled surface (68) with the tapered inner surface (72, 74) of the deformable annular end portion (71) to the outer end (78) of the deformable annular end portion (71).

73. (previously presented) The combination of claim 70 wherein the curved outside surface (60) of the formed end (20) merges into a generally flat outside surface (62) that extends toward the spindle rotational axis (X) from the curved outside surface (60).

74. (previously presented) The combination of claim 70 wherein the formed end (20) tapers to a relatively sharp rounded edge at said peripheral outside corner (64) thereof.

75. (previously presented) The combination of claim 70 wherein the diagonal thickness of the formed end in a direction generally diagonally across the inside corner (56) and the intersection of the spindle inner beveled surface (68) with the outside intersection (C) is not less than the axial thickness (between 58 and 62) of the formed end (20) at a location in alignment with the interface (between 15 and 27) between the cylindrical opening (27) in the component (26) and the spindle outer surface (15).

76. (previously presented) The combination of claim 70 wherein the tapered inner surface (72, 74) of the deformable annular end portion (71) intersects the inner beveled surface (68), the outward deformation of the deformable annular end portion (71) being such that the tapered inner surface (72, 74) of the deformable annular end portion (71) is outwardly deformed along its length from adjacent its intersection (C) with the inner beveled surface (68) to its outer end (78).

77. (previously presented) In an assembly wherein a component (26) is secured on a spindle (15) by a formed end (20) that is formed by deformation of a deformable spindle annular end portion (71);

the spindle (15) having a spindle rotational axis (X FIG. 1), outer and inner spindle cylindrical surfaces (15, 22), and a deformable annular end portion (71) with an outer end (78);

the deformable annular end portion (71) having a cylindrical outer surface (71a) and a tapered inner surface (72, 74) that tapers outwardly away from the spindle rotational axis (X) toward the outer end (78) so that the deformable annular end portion (71) decreases in radial thickness (between 71a and 72, 74) along its length in a direction toward its outer end (78);

the component (26) having an opening (27) in which the spindle (14) is received for rotation of the component (26) with the spindle (14);

the spindle deformable annular end portion (71) being deformed generally radially outwardly and axially into a formed end (20) that engages an outer face (32) of the component (26) to secure the component (26) on the spindle (14);

the formed end (20) extending outwardly of the spindle axis (X) and terminating in a peripheral outside corner (64) located closely adjacent the outer face (32) of the component (26);

the deformable annular end portion (71) of the spindle (14) being deformed and worked so that both the outer end (78) and at least a portion of the tapered inner surface (72, 74) of the deformable annular end portion (71) are formed into a single continuously curved outside surface (60) on the formed end (20) that curves smoothly along its length toward the spindle rotational axis (X) from the peripheral outside corner (64) of the formed end (20) that is located closely adjacent the outer face (32) of the component (26);

the formed end (20) having an inside face (58) that engages the outer face (32) of the component (26) and merges into the outer cylindrical spindle surface (15) along an inside corner (56);

the formed end (20) having a generally axially facing outside surface (60, 62) that merges into the internal surface (22) of the spindle (14) along an outside transition (66, 68);

the outside transition (66, 68) being shaped and configured to cut generally diagonally across between the internal surface (22) of the spindle (14) and the axially facing outside surface (60, 62) of the formed end (20);

the outside transition (66, 68) being shaped and configured other than as a continuous smooth curve or as a right angle while including at least one generally plane surface (66 or 68) that is inclined outwardly from the spindle inner surface (22); and

the shape and configuration of the outside transition (66, 68) being such that the outside transition (66, 68) is closer to the inside corner (56) than would be an outside transition formed by a continuous outwardly convex smooth curve tangent to the outside surface (60, 62) of the formed end (20) to thereby provide the formed end (20) with a reduced thickness in a direction generally diagonally across the inside corner (56) and the outside transition (66, 68).

78. (previously presented) The combination of claim 77 wherein the diagonal thickness of the formed end (20) in a direction generally diagonally across the inside corner (56) and the outside transition (66, 68) is not less than the radial thickness (between 71a and 72, 74) of the spindle deformable annular end portion (71) at any location along its length (from C to 78).

79. (previously presented) The combination of claim 77 wherein the generally axially facing outside surface (60, 62) of the formed end (20) includes a curved outside surface (60) that merges into a generally flat outside surface (62) that extends toward the spindle rotational axis (X) from the curved outside end surface (60).

80. (previously presented) In combination:
a spindle (14) having a component (26) secured thereto by a formed end (20) that is formed by deformation of a deformable annular end portion (71) on the spindle (14);

the component (26) having a cylindrical opening (27) therethrough and an outer face (32);

the spindle (14) having a spindle rotational axis (X FIG. 1), a spindle outer surface (15) and a deformable annular end portion (71) with an outer end (78);

the spindle (14) having an inner beveled surface (68) that is inclined inwardly toward the spindle rotational axis (X) from the deformable annular end portion (71);

the deformable annular end portion (71) having a cylindrical outer surface (71a) and a tapered inner surface (72, 74) that intersects (C) the inner beveled surface (68);

the tapered inner surface (72, 74) tapering outwardly away from the spindle rotational axis (X) from its intersection (C) with the inner beveled surface (68) in a direction toward the outer end (78) so that the deformable annular end portion (71) decreases in radial thickness (between 71a and 72, 74) along its length in a direction toward its outer end (78);

the deformable annular end portion (71) being received through the opening (27) in the component (26) and being deformed generally radially outwardly and axially into a formed end (20) that holds the component (26) on the spindle (14), the deformation being such that the cylindrical outer surface (71a) of the deformable annular end portion (71) becomes an inner face (58) of the formed end (20) that extends outwardly of the spindle rotational axis (X) in engagement with the outer face (32) of the component (26); and

the tapered inner surface (72, 74) of the deformable annular end portion (71) being outwardly deformed along its length from adjacent its intersection (C) with the inner beveled surface (68) to its outer end (78).

81. (previously presented) The combination of claim 80 wherein the inner face (58) of the formed end (20) merges with the spindle outer surface (15) along an inside corner (56), and the intersection (C) between the outer surface (60, 62, 66) of the formed end (20) and said inner beveled surface (68) is located generally diagonally opposite from said inside corner (56).